West African Electrification: Complementary Options Using Sustainably derived Biomass

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West African electrification

- Complementary options using sustainably derived biomass

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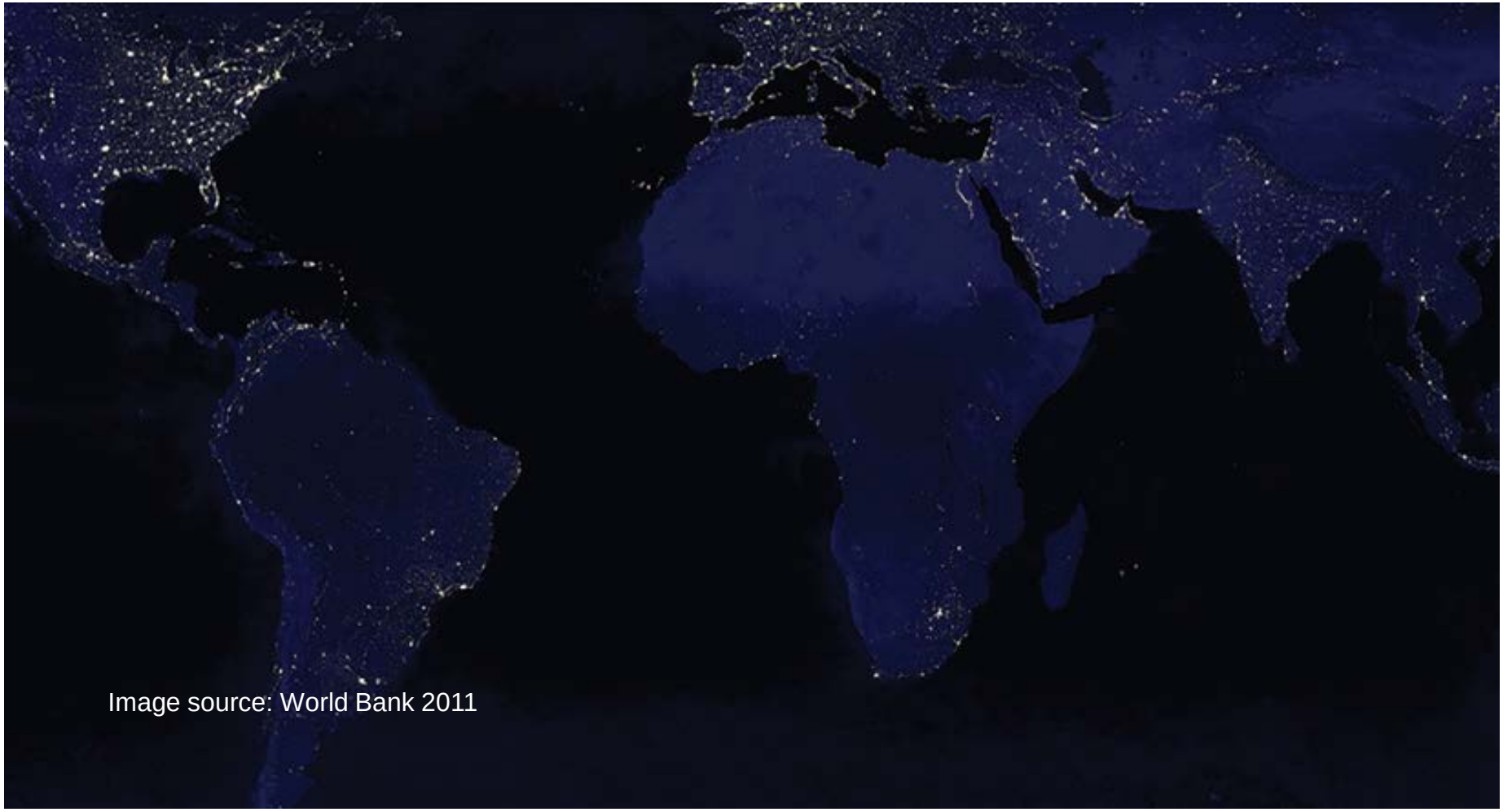
Africa - Year 2013



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The UN General Secretary Goals:

1. Universal Energy Access goal

2. Doubling the rate of improvement in Energy Efficiency

3. Doubling the amount of renewables in the global energy mix

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Outline

- Resource estimation for the15 member states
- Highlighting some case examples i.e. Benin, Ghana, Togo, Senegal & Nigeria
- Bioelectricity potential
- Decentralized applications
- Should be supplemented with edapho-climatic studies
- Recommendations

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How do we get from:

A **to** **B ?**

- Key questions:
  - where?
  - what?
  - why?
  - how?

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How do we go from:

- Political will
- Resource assessment
  - conventional energy sources
  - renewables (Denmark Technical University/UNEP Risø, IRENA, NREL etc)
- Environmental sustainability
- Socio-economics
- Financing
- Comprehensive policies
- Capacity development
- Demand driven rather than supply push
- AGECC 3 steps approach
- Energy PLUS approach
- E.T.C.

Biomass resource assessment - GNESD

Energy from crops

Sustainability discussions: env'tal, social criteria

Bioenergy crops/plantations

- Ecological mapping in Brazil, Senegal and Kenya
- Plus sustainability considerations in Argentina & Thailand

References:
1. GNESD. 2013. Biofuels Sustainability Country Reports.
2. Kumar S, Salam PA, Shrestha P, Ackom EK. An Assessment of Thailand's Biofuel Development. *Sustainability*. 2013; 5(4):1577-1597.

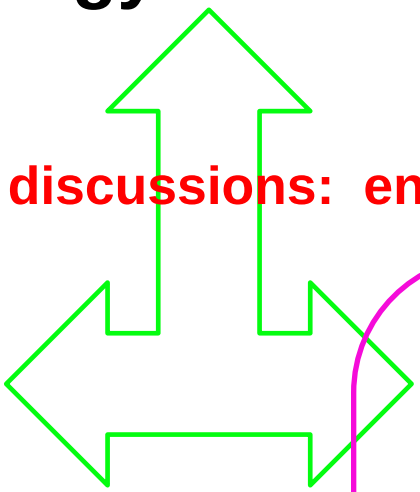
Agricultural crop residues

- Resource estimation 15 states
- 5 selected case examples
- Need to supplement with edaphic-climatic studies
- Bioelectricity potential
- Decentralized systems

Recommendations

Biomass resource assessment – (contd.)

Energy from crops



Sustainability discussions: env'tal, social criteria

Bioenergy crops

- Ecological mapping in Brazil, Senegal and Kenya
- Plus sustainability considerations in Argentina & Thailand

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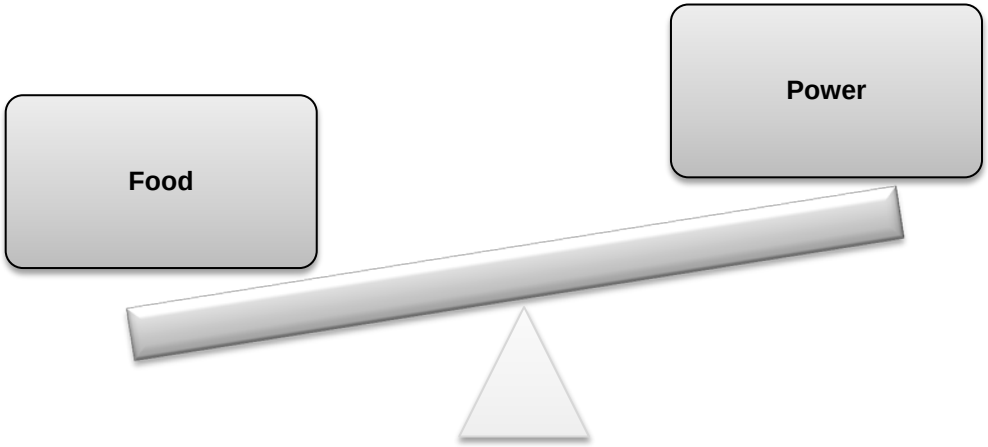
Agricultural crop residues

Other studies/reports including:

- GNESD 2011;
- IRENA, 2012;
- ECOWAS Bioenergy Programme;
- Nygaard *et.al.* 2012;
- Feasibility of Resources for Sustainable Energy in Mali (FRSEM)

Food or Power?



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Why must we choose?

Can't we have both?

Food

photo credit: randomactsofkelliness.com

&

Power

photo credit: Ivan Nygaard, URC

i.e. integrated food and fuel systems:

decentralized scales in the farming communities/rural areas

Sometimes this is Business-As-Usual in some places

photo credit: hotstuffclimatenet.org

photo credit: ripley.za.net

photo credit: energypedia.info

In other places,
just when life seem getting better .....

photo credit: Ivan Nygaard, URC

photo credit: Ivan Nygaard, URC

photo credit: Ivan Nygaard, URC

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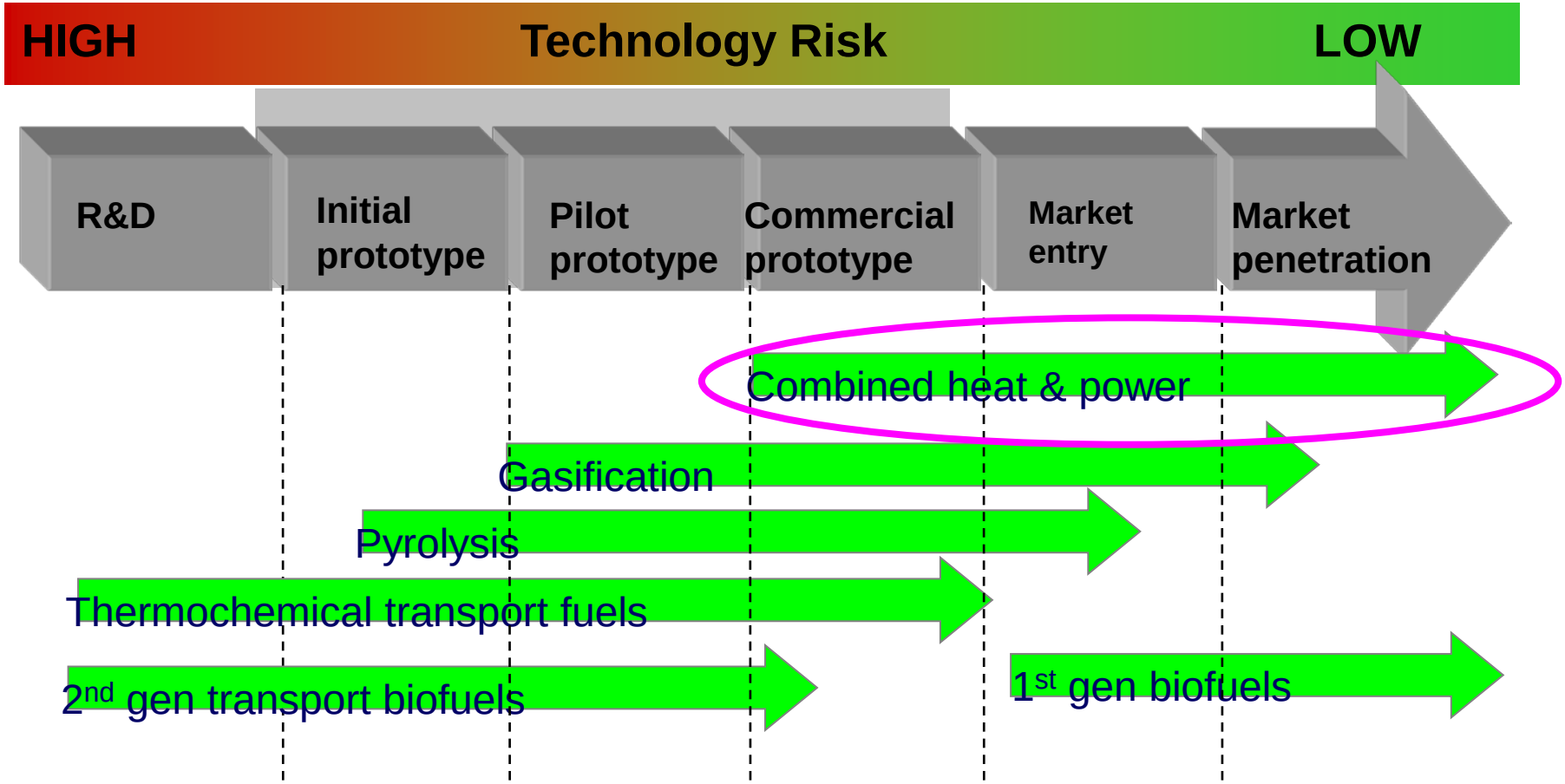
Good case for modern bioenergy

- Lack of Infrastructure
- Price volatilities in crude oil
- Remoteness

- Localization of the bioresource
- Cheaper, however storage, logistics etc
- Not so much of a problem

Bioenergy – which technological option?



(Adapted from Ceres Ventures 2007 by IEA Task 39)

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Benin

Bioelectricity potential agric. residues (GNESD year 2011 est.)

Crop	Residues	Sustainable derived residue	Bioelectricity 15% effic. (MWh)	Bioelectricity 40% effic. (MWh)
	dry wt.	20% extraction	Low	High
Maize	1.5E+06	2.9E+05	1.9E+05	5.1E+05
Millet	3.1E+04	6.3E+03	4.0E+03	1.1E+04
Rice	2.2E+05	4.3E+04	2.8E+04	7.6E+04
Sorghum	3.5E+05	6.9E+04	4.9E+04	1.3E+05
Sugarcane	3.6E+03	7.2E+02	4.1E+02	1.1E+03
Coconut	10.0E+03	2.0E+03	8.9E+02	2.4E+03
GrossTotal		***6.5E+06***	***2.7E+05***	***7.3E+05***
National electricity cons. = 0.88TWh			***31%***	***83%***

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Ghana

Bioelectricity potential agric. residues (GNESD year 2011 est.)

Crop	Residues	Sustainable derived residue	Bioelectricity 15% effic. (MWh)	Bioelectricity 40% effic. (MWh)
	dry wt.	20% extraction	Low	High
Maize	2.2E+06	4.3E+05	2.8E+05	7.5E+05
Millet	2.3E+05	4.7E+04	3.1E+04	8.2E+04
Rice	5.9E+05	1.2E+05	7.7E+04	2.1E+05
Sorghum	6.4E+05	1.3E+05	9.1E+04	2.4E+05
Coconut	1.6E+05	3.2E+04	1.4E+04	3.9E+04
Cocoa	6.0E+05	1.2E+05	7.7E+04	2.1E+05
Gross Total		***8.8E+05***	***5.7E+05***	***1.5E+06***
National electricity cons. = 7.3TWh			***8%***	***21%***

Togo

Bioelectricity potential agric. residues (GNESD year 2011 est.)

Crop	Residues	Sustainable derived residue	Bioelectricity 15% effic. (MWh)	Bioelectricity 40% effic. (MWh)
	dry wt.	20% extraction	Low	High
Maize	8.3E+09	1.7E+05	1.1E+05	2.9E+05
Millet	6.4E+04	1.3E+04	8.4E+03	2.2E+04
Rice	1.4E+05	2.9E+04	1.9E+04	5.0E+04
Sorghum	5.4E+05	1.1E+05	7.7E+04	2.1E+05
Coffee	2.2E+04	4.5E+03	2.4E+03	3.0E+04
Cocoa	8.5E+04	1.7E+04	1.1E+04	6.3E+03
Gross Total		**3.4E+05**	**2.3E+05**	**1.3E+07**
National electricity cons. = 0.7TWh			***33%***	***89%***

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Senegal

Bioelectricity potential agric. residues (GNESD year 2011 est.)

Crop	Residues	Sustainable derived residue	Bioelectricity 15% effic. (MWh)	Bioelectricity 40% effic. (MWh)
	dry wt.	20% extraction	Low	High
Maize	2.4E+05	4.8E+04	3.9E+04	8.3E+04
Millet	2.1E+06	4.2E+05	2.7E+05	7.2E+05
Rice	7.7E+05	1.5E+05	1.0E+05	2.7E+05
Sorghum	3.6E+05	7.2E+04	5.7E+04	1.4E+05
Sugarcane	6.4E+05	1.3E+04	7.2E+03	1.9E+04
Coconut	2.8E+03	5.5E+02	2.5E+02	6.6E+02
Gross Total		**7.0E+05**	**4.6E+05**	**1.2E+06**
National electricity cons. = 2.43TWh			***19%***	***51%***

Nigeria

Bioelectricity potential agric. residues (GNESD year 2011 est.)

Crop	Residues	Sustainable derived residue	Bioelectricity 15% effic. (MWh)	Bioelectricity 40% effic. (MWh)
	dry wt.	20% extraction	Low	High
Maize	1.2E+07	2.3E+06	1.5E+06	4.1E+06
Millet	1.6E+06	3.2E+05	2.1E+05	5.6E+05
Rice	5.8E+06	1.2E+06	7.6E+05	2.0E+06
Sorghum	1.5E+07	3.1E+06	2.2E+06	5.9E+06
Sugar cane	1.1E+05	2.2E+04	1.2E+04	3.3E+04
Cocoa	3.4E+05	6.8E+04	4.4E+04	1.2E+05
Gross Total		***7.0E+06***	***4.8E+06***	***1.3E+07***
National electricity cons. = 21.6TWh			***22%***	***59%***

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Summary - bioelectricity potential in selected West African countries

(GNESD estimation)

Countries	Electricity consumption (TWh)	Bioelectricity (agric) worst case	Bioelectricity (agric) best case
Benin	0.88	19%	51%
Ghana	7.3	8%	21%
Togo	0.7	33%	89%
Senegal	2.43	19%	51%
Nigeria	21.6	22%	59%

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Need for Economic Analysis

- Detailed location specific economic analysis information gap
- However a general study done by IRENA, 2012 shows

Bioelectricity technologies	Investment costs (USD/kW)	Levelized Cost of Electricity range (USD/kWh)
Stoker boiler	1880-4260	0.06-0.21
Bubbling & circulating fluidized boiler	2170-4500	0.07-0.21
Stoker CHP	3550-6820	0.07-0.29
Gasifier	5570-6545	0.11-0.28

- Possibly an area for future GNESD investigation

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Recommendations

- Sustainably derived agricultural residues show good potential to make significant contributions to electrification via decentralized systems
- Admittedly, the potential from agricultural residues varies from country to country.
- Ranges from Cape Verde (0.03-0.07%) to Togo (33-89%) in national electricity consumption amounts.
- Additional investigations on the edapho-climatic factors regarding the agricultural residues resource assessment.
- Need to be supplemented with a detailed economic analysis.

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Thank you very much

Questions and comments

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